CEMP-ET DEPARTMENT OF THE ARMY ETL 1110-1-177
U.S. Army Corps of Engineers
Washington, D.C. 20314-1000

Engineer Technical
Letter 1110-1-177 31 December 1996

Engineering and Design
USE OF RESIN MODIFIED PAVEMENT

1. Purpose. This letter provides state-of-the-art guidance on the design and use of resin modified pavement (RMP).

2. Applicability. This Engineer Technical Letter (ETL) is applicable to all HQUSACE elements and USACE Commands having military and civil works construction responsibility.

3. References. References providing necessary general information, background, definitions and design guidance for resin modified pavements are listed in Appendix A.

4. Discussion.

a. Description. Resin modified pavement (RMP) is a composite pavement surfacing that uses a unique combination of asphalt concrete (AC) and portland cement concrete (PCC) materials in the same layer. The RMP material is generally described as an open-graded asphalt concrete mixture containing 25- to 35-percent voids which are filled with a resin modified portland cement grout. The open-graded asphalt mixture and resin modified cement grout are produced and placed separately. The open-graded mixture is produced in a typical asphalt concrete plant and placed with standard asphalt paving equipment. After the open-graded layer has cooled, the grout is poured onto the porous surfacing and vibrated into the internal voids. The RMP layer is typically 50 mm (2 in.) thick and has a surface appearance similar to a rough-textured PCC.

b. Materials and Construction. The open-graded asphalt mixture is designed to be the initial "skeleton" of the RMP. A coarse aggregate gradation with very few fines is used along with a low asphalt cement content (typically 3.5 to 4.5 percent by total weight) to produce 25- to 35-percent voids in the mix after construction. The open-graded asphalt mixture can be produced in a conventional batch plant or drum-mix plant. After placing, the open-graded asphalt material is smoothed over with a minimal number of passes (usually 2 or 3) from a small (3-tonne maximum) steel-wheel roller.

(1) The resin modified cement grout is composed of fly ash, silica sand, cement, water, and a cross polymer resin additive. The resin additive is generally composed of five parts water, two parts polymer resin of styrene and butadiene, and one part water-reducing agent. The grout water/cement (w/c) ratio is

between 0.65 and 0.75, which provides a very fluid consistency. The cement grout material can be produced in a conventional concrete batch plant or a small portable mixer. After the asphalt mixture has cooled, the grout is poured onto the open-graded asphalt layer and squeegeed over the surface. The grout is then vibrated into the voids with the 3-tonne vibratory steel-wheel roller to ensure full penetration of the grout. This process of grout application and vibration continues until all voids are filled with grout.

(2) Depending upon the specific traffic needs, the freshly grouted surface may be hand broomed or mechanically textured to improve skid resistance. In most circumstances, however, the excess grout is squeegeed off of the pavement surface, and a natural rough texture is achieved through evaporation of surface bleed water. Spray-on curing compounds, typical to the PCC industry, are generally used for short-term curing. The new RMP surfacing usually achieves full strength in 28 days, but it may be opened to pedestrian traffic in 24 hours and light automobile traffic in 3 days.

c. Pavement Design. The pavement thickness for the RMP is to be determined using flexible pavement criteria. The total pavement thickness for a pavement structure including the RMP should be determined using TM 5)822)5 and TM 5)825)2. After the pavement thickness has been determined for a particular load and level of traffic, the top 50 mm of the asphalt concrete layer are to be replaced with 50 mm of the RMP. This is a conservative design approach, but pending the outcome of further research in this area, all RMP projects should be designed as a conventional flexible pavement in this manner.

(1) In rehabilitation projects such as overlays, the overlay pavement thickness should be determined to satisfy traffic and load requirements. The minimum overlay thickness is 50 mm when using the RMP. If additional thickness is required, the remaining pavement thickness underlying the RMP surface should consist of high-quality asphalt concrete.

(2) RMP has been successfully constructed as an overlay material over rigid and flexible pavements as well as in original construction. No transverse or longitudinal joints are required for original, full-depth RMP designs although joints have been cut in RMP when overlaying jointed PCC pavement. Cracking and seating of existing PCC and then overlaying with an AC interlayer and RMP surfacing has been a successful design approach. Pavement joints are required between RMP and adjacent PCC pavements but are not required between RMP and adjacent AC

pavements. These joints are constructed by saw cutting to the bottom of the RMP layer once the RMP material has sufficiently cured. The joint is then filled with a sealant material suitable for the particular site conditions.

(3) Mix design methodologies for RMP have not been previously documented. All RMP military construction projects to date have had Government provided mix designs, provided by the U.S. Army Engineer Waterways Experiment Station, CEWES-GP, Vicksburg, MS, 39180. The mix design method found in Appendix B provides suitable job-mix formulations for both the open-graded asphalt concrete and grout materials when designing an RMP. This mix design method also contains appropriate procedures for quality control testing of open-graded AC voids and grout viscosity.

d. Applications. RMP may be used in new pavement construction or in the rehabilitation of existing pavement structures. A new RMP surfacing may be placed as an overlay over existing flexible or rigid pavements. RMP is typically used as a low-cost alternative to a PCC rigid pavement or as a means of improving the pavement performance over an AC surfaced flexible pavement. Field experience indicates that RMP may be used in practically any environmental conditions.

(1) In general, the RMP is best suited for pavements that are subjected to low-speed traffic that is channelized or abrasive by nature. Pavement areas with heavy static point loads and heavy fuel spillage are also ideal RMP application candidates. The practical limit for the surface slope of an RMP section is 2 percent. Pavement slopes up to 5 percent can be constructed, but excess hand work and grout overruns are to be expected with slopes greater than 2 percent.

(2) The RMP process has been used in a variety of applications on the international market, including airport and vehicular pavements, industrial and warehouse floorings, fuel depots and commercial gasoline stations, city plazas and malls, railway stations, and port facilities. Since its first commercial application in the United States in 1987, RMP has been used mostly on airport and airfield pavement projects. These applications have included taxiways, aprons, equipment and fuel storage areas, and warehouse parking lots. As of September 1996, there were 17 known RMP project sites in the United States, totaling over 180,000 sq m (216,000 sq yd) of pavement area.

e. Costs. The cost of a 50-mm-thick (2-in.) RMP layer is currently about $9.60 to 19.20 per sq m ($8 to 16 per sq yd) as compared to a typical cost of $3.60 to 6.00 per sq m ($3 to 5 per sq yd) for a 50-mm-thick (2-in.) layer of dense-graded asphalt concrete. The initial cost of a full-depth RMP design is generally 50 to 80 percent higher than a comparable asphalt concrete design when considering a heavy-duty pavement. A more important cost comparison is between the RMP design and the rigid pavement design since the RMP is usually used as a cost saving alternative to the standard PCC pavement. In the case of a standard military heavy-duty pavement application, the RMP design is generally 30 to 60 percent less in initial cost than a comparable PCC pavement design. In many circumstances, the RMP also provides life cycle cost savings from reduced or eliminated maintenance efforts when compared to flexible pavements and jointed rigid pavements.

5. Action. The enclosed mix design method should be used for determining job-mix formulations relating to the construction of RMP. Guidance on the use of RMP is available from the U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, CEWES-GP, Vicksburg, MS 39180.

6. Implementation. This letter will have routine application for military construction as defined in paragraph 6c, ER 1110-345-100.

FOR THE DIRECTOR OF MILITARY PROGRAMS:

2 Appendices
APP A-References
APP B-Resin Modified Pavement (RMP) Mix Design Method

KISUK CHEUNG, P.E.
Chief, Engineering Division
Directorate of Military Programs